Author's Accepted Manuscript

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PII: S0166-0462(16)30236-8
DOI: http://dx.doi.org/10.1016/j.regsciurbeco.2017.11.002
Reference: REGEC3311

To appear in: *Regional Science and Urban Economics*

Received date: 11 October 2016
Revised date: 12 June 2017
Accepted date: 1 November 2017

Cite this article as: Sean O'Connor, Eleanor Doyle and Justin Doran, Diversity employment growth and spatial spillovers amongst Irish regions, *Regiona Science and Urban Economics* http://dx.doi.org/10.1016/j.regsciurbeco.2017.11.002

Diversity, employment growth and spatial spillovers amongst Irish regions

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Abstract

Regional employment growth has become an area of increasing interest to academics and policymakers alike over recent years. To date little empirical research has been undertaken in regards to the relationship between economic diversity and regional employment growth with even less research considering the potential for regional spillovers. This paper analyses this gap in the existing literature by considering the roles of three categories of diversity (total, related and unrelated) on Irish employment growth over the period 2006-2012. Utilising a spatial econometric model we note not only the positive effect of spatial spillovers in regards to employment growth, but also the differing impacts of all three measures. Our results indicate that for this particular period a diverse industry structure has a significant positive impact on employment growth. We find that total diversity and its two sub-components related and unrelated diversity positively effects employment growth. Unrelated diversity is found to have the largest positive effect.

Keywords: Regional Employment Growth; Related and Unrelated Diversity; Ireland; Spatial Spillovers.

1. Introduction

There has been increasing interest in the drivers of regional employment growth in recent years preceding and following the onset of the global financial crisis (Frenken et al. 2004; Martin et al 2016; Doran et al 2016). Significant regional disparities exist in regional employment growth rates across Europe (see Funck and Pizzati, 2003; Borys et al., 2008 and Marelli and Signiorelli, 2010a) with differentials in regional growth rates having an impact on the economic, social and territorial cohesion of countries. Significant policy interventions take place to reduce regional disparities with European structural funds and cohesion funds as two examples of such instruments. A greater understanding of the drivers of employment growth is important as persistent differences in employment growth rates across regions can have significant implications for long-run regional economic convergence or divergence (Martin et al 2016).

This is increasingly the case in the context of economic resilience, where diversity of structure is proposed to insulate regions from shocks and aid them in rebounding following a crisis (Doran and Fingleton 2013). The implications of different growth paths has lead authors such as Martin (2012; 2016) to argue that these different growth rates may lead to long run increases in inequality between regions. Indeed, much of the empirical research to date is framed around whether growth rates are converging as predicted by the neoclassical work of Solow (1956) or diverging, thus deepening regional inequalities. Doran and Jordan (2013) noted that although disparities in income inequality have reduced between EU countries, within-country disparities have actually increased in the three decades to 2009. Marelli and Signiorelli (2010a, 2010b) find similar trends.

Recently the role of industrial structure on regional employment has received increasing attention. One stream of research, focusing on Jacobian effects, proposes that increased diversity in industrial structure can stimulate employment growth and also insulate regions against the negative effects of external shocks. A significant number of empirical studies, such as by Feldman and Audretsch (1999), Attaran and Zwick (1987), Paci and Usai (2002), Van Oort (2007), Frenken et al. (2007), Bishop (2008), Bishop and Gripaios (2010) and Pede (2013) provide empirical support for the Jacobian hypothesis. These studies all report a positive relationship between regional economic diversity and employment growth. However, in tandem with this increased interest in diversity as a driver of employment growth, there has also been an increased interest in the extension of regional employment models to account for spatial dependence. Recent studies which consider employment growth models (such as Verdoorn's law for example) emphasises the interconnectedness of regions, with positive and negative shocks in neighbouring regions spilling over to impact others (Fingleton et al 2012, 2015, Doran and Fingleton 2014, McCombie et al 2017).

In the Irish context, this concept of regional industry structure and divergence in employment is receiving increasing attention with a new National Planning Framework (Department of Housing, Planning, Community and Local Government, 2017) which has a specific focus on promoting balanced regional development. This Framework specifically questions the types of industry structures which should be targeted in order to promote convergence of employment growth across Irish regions. For Ireland this research questions has long been relevant. Recently, O'Leary and Webber (2015) in their study of the role of structural change on European regional productivity for 181 NUTS2 European regions from 1980 to 2007, noted that in Ireland the South-East (SE) region, although more productive, was deteriorating over the period, while the Border Midlands West (BMW) region although a relatively less productive region was improving. They attribute this to changes in their industrial structure over this period.

Our paper specifically analyses the role of specialisation and diversity of industry structure in driving employment growth across Irish regions (Cingano and Schivardi, 2004). To accomplish this, data on 27 Irish regions is generated using business administration records held by the Irish Central Statistics Office (CSO). These data catalogue the number of employees in each Irish region across NACE 4-digit sectors. This highly disaggregated data is used to calculate our indicators of regional diversity. This administrative data is combined with publically available regional data on disposable income, population density, and firm size to complete our dataset. We employ a spatial panel econometrics model to estimate the impact of diversity on employment growth. The use of spatial econometrics methods allows us to control for the impacts of spatial spillovers across Irish regions. A selection of models are considered and, using the selection procedure suggested by LeSage and Pace (2009) the final model employed is a Spatial Durbin Model (SDM). From this we estimate the direct, indirect and total effects in line with Elhorst (2009).

The remainder of this paper is structured as follows. Section 2 discusses the literature relating to regional employment growth, as well as framing our contribution to the existing literature. Section 3 outlines our model along with the estimation method. Second 4 presents the data. Section 5 discusses our estimation results. The final section concludes.

2. Factors influencing employment growth

A variety of factors drive sub-national differences in regional growth rates (Hofer and Wörgötter, 1997). Among these factors are the industrial structure (in terms of diversity or specialisation) of the region (Grimaios, 2000), the degree of competition firms face (Chiting 1961), the proximity of the region to major urban areas, capital city effects, and the degree of urbanisation of the region growth (Begovic, 1992; Roberts, 2004). The key elements of interest in the context of the current study in the diversity of a region's industry structure (although in our modelling approach we do control for other factors relating to competition, urbanisation and agglomeration effects).

Focusing on diversity and specialisation, empirical investigations of these two phenomenon have provided mixed results (Pede, 2013). Hackbart and Anderson (1975) and Dissart (2003) argue that proponents of economic diversity suggest diverse economies are more protected from volatility of the business cycle, thus better equipped to avoid large fluctuations in employment and income, than economies that are more specialised. Regions which are diverse in economic structure may benefit from Jacobian (1969) externalities, as diversity within a region promotes technological innovation and spillovers across sectors. Research by Feldman and Audretsch (1999) provides empirical support for the Jacobian hypothesis. Attaran and Zwick (1987), Paci and Usai (2002), Van Oort (2007), Frenken et al. (2007), Bishop (2008), Bishop and Gripaios (2010) and Pede (2013) all report a positive relationship between regional economic diversity and employment growth. However, Shearmur and Polèse (2005) find no long-term evidence of diversity and employment growth in Canada.

Conversely, MAR (Marshall-Arrow-Romer) externalities, also known as localisation economies imply regional specialisation may enable economic growth. Specialization by particular sectors can foster innovation, and in turn benefit regional prosperity as firms not only compete with each other for scarce resources, but also cooperate. The finding that specialisation has had a negative impact on employment growth is evident in Combes (2000), Forini and Paba (2002) Paci and Usai (2006), Deidda et al. (2002), and Bishop and Gripaois (2010). Delgado et al. (2014) noted the positive role of cluster-based agglomerations in benefiting regional performance, namely that of employment and wage growth across regions of the United States.

There is a strong pedigree in the regional science literature, which has seen increased consideration of late, of augmenting regional employment growth models to account for spatial dependence. In the context of models based on Verdoorn's law Fingleton and McCombie (1998) and McCombie et al (2017) show that spatial patters are observed in employment growth rates and discuss the importance of the extension of the standard models to incorporate spatial econometric techniques in the case of Fingleton and McCombie (1998) and the importance of overcoming the spatial aggregation bias in the case of McCombie et al (2017). The importance of accounting for spatial spillovers in employment growth models is also discussed at length in the regional economic resilience literature with authors such as Fingleton et al (2012, 2015) and Doran and Fingleton (2014) highlighting that shocks propagate across regions.

As the above highlights, a substantive literature has developed examining the sources of disparities in regional economies. However, as Bishop (2008) highlights much of the existing evidence has been derived from continental European countries, with more recent work including Britain. To date little investigation has been undertaken for regions of the Republic of Ireland. Thus, we add to the literature by providing an empirical assessment of the role local externalities exert, along with spatial, industrial and competitive effects on employment growth in Ireland.

3. Modelling Employment Growth

Our empirical estimations of employment growth are based on variations of a model developed by Glaeser et al. (1992) as elaborated upon in Bishop (2008). This framework utilises a simple production function model, along with a single labour unit. Our model is chosen due to the lack of data on local capital inputs available regionally for Ireland (a problem which is common in regional analysis as discussed in Bishop (2008) in the context of Great Britain). We assume an enterprise has a production function $A_t f(l_t)$, where A_t represents technology at time t and l_t labour input. Profit maximization yields $A_t f'(l_t) = w_t$, where w_t is the wage rate. In relation to growth rates this yields:

$$\log\left(\frac{A_{t+1}}{A_t}\right) = \log\left(\frac{w_{t+1}}{w_t}\right) - \log\left(\frac{f'(l_{t+1})}{f'(l_t)}\right) \tag{1}$$

It assumed that technological growth can be decomposed into a national component, which is homogenous across regions, as well as a local component which is related to various local externalities. Setting $f(l) = l^{1-\alpha}\ (0 < \alpha < 1)$, denoting national technology at time t as $A_{national,t}$ and $g(.)$ to represent local effects yields the following:

$$\begin{aligned} \alpha \log\left(\frac{l_{t+1}}{l_t}\right) &= -\log\left(\frac{w_{t+1}}{w_t}\right) + \log\left(\frac{A_{national,t+1}}{A_{national,t}}\right) \\ &+ g(externalities, other\ \text{local effects}) \end{aligned} \tag{2}$$

As national technology growth is assumed constant across regions, Equation 2 implies that local employment growth can be explained by $g(externalities, other\ local\ effects)$ along with wage growth.[1]

We follow recent papers such as Fingleton et al (2012, 2015) who extent standard non-spatial employment growth models to incorporate spatial effects. In our case to factor in spatial spillovers we extend the theoretical model proposed above to allow spatial effects, i.e. interdependencies across regions (Tobler, 1970).

For simplicity, we rewrite equation (2) in vector form and group the various factors which can influence regional employment growth into a singular notation referred to as rc.Thus, a simple pooled linear regression model is presented in equation (3) which is the starting point for the development of the spatial model.

$$empg_{it} = rc_{it}\beta + \varepsilon_{it}, \tag{3}$$

Where i is an index for the cross-sectional dimension (spatial units), with $i = 1,....,N,$ and t is an index for the time dimension (time periods), with $t = 1,....,T,$. $empg$ is a measure of growth in employment at i and t, rc_{it} is an $(1,K)$ row vector of regional characteristics on the independent variables, with β the subsequent matching $(K,1)$ vector of fixed, but unknown parameters. ε_{it} is an independently and identically distributed error term for i and t, with zero mean and variance σ^2.

The baseline model provided in equation (3) ignores possible spatial effects in analysing the impact of diversity, along with other regional factors on employment growth. Given the spatial unit of choice employed by this study is based on administrative boundaries, rather than economic regions, it might be expected that spillovers would exist from neighbouring regions (as shown in Bishop, 2008, Bishop and Gripaios, 2010, amongst others). We begin by specifying a full Spatial Durbin Model (SDM) which takes the form of the following;

$$empg_{it} = \rho Wempg_{jt} + rc_{it}\beta_1 + Wrc_{jt}\beta_2 + \varepsilon_{it} \quad (4)$$

The spatial autoregressive (SAR) model is nested within the SDM (i.e. when $\beta_2 = 0$ and $\rho \neq 0$) and the spatial error model (SEM) is also nested within the SDM (i.e. while if $\beta_2 = -\beta_1\rho$). Within the spatial econometrics literature equation (4) is known as the unconstrained SDM. It includes both the spatially lagged values of both dependent and independent variables. This shows that unlike non-spatial panel models, the link between diversity, employment growth and other regional factors is not only a function of explanatory variables in region i, but also employment growth and certain explanatory variables of neighbouring regions j. Similar to the baseline model, equation (3), diversity, along with a number of other regional characteristics denoted by rc_{it} have an impact on employment growth in a given region. The SDM allows for observed values of neighbouring regions employment growth $(Wempg_{it})$ along with other regional characterises of neighbouring regions $(Wrc)_{it}$ to impact a region's employment growth rate. The coefficient ρ quantifies employment growth's impact of neighbouring regions on the employment growth rate of a particular region or in other words, the spatially lagged dependent variable.

W signifies our spatial weights matrix. The matric is of dimensions $N*N$. In our case we begin with a contiguity matrix, which takes a value of 1 if two regions share a border and a value of 0 otherwise. The leading diagonal of the matrix (which indicates the proximity of a region to itself) take values of 0. As is standard we row normalise the matrix. This involves dividing each value in a row by the sum of the values in that row. This ensures that each of rows sum to unity. This is one of the most common specifications of the W matrix and is used extensively in the spatial econometrics literature (Le Sage and Pace 2009, Corrado and Fingleton, 2012, Elhorst, 2014).

A common problem identified by LeSage and Pace (2010) and Elhorst (2009) is that of selecting the correct type of spatial model. While the model presented in equation (4) is a spatial Durbin model we do not presume *a priori* that this is the optimal model to use. Instead, based upon this we impose restrictions to test which of the following models are preferred; the spatial Durbin model (SDM), the spatial autoregressive model (SAR) or the spatial error model (SEM). We follow the procedures described by LeSage and Pace (2009) and Elhorst (2009) in refining our model selection. We begin with the spatial Durbin model (SDM) in equation (4). Belotti et al. (2016), following the strategy of LeSage and Pace (2009) and Elhorst (2009), highlight that the SDM model can be utilised as a general specification, and then tested against the various alternative specifications (SAR and SEM). Following the estimation of the SEM it is possible to test if this can be simplified to a SAR if $\beta_2 = 0$ and $\rho \neq 0$ while if $\beta_2 = -\beta_1\rho$ then the model can be simplified to a SEM. To implement these tests, it is first necessary to estimate the spatial panel model in equation (4).

Once the model has been estimated, as noted in Elhorst (2009) it is possible to obtain additional information on the impacts of the variables on the dependent variable by calculating the direct and indirect effects for each variable. These provide a more accurate overview of the impact of the independent variables as they take account of the significant spatial effects. These are calculated as the partial derivatives of *empg* with respect to each individual independent variable.

The matrix of partial derivatives of $empg$ with respect to the various regional explanatory variables rc for $i = 1,...., N$ gives the following

$$\left[\frac{\partial empg}{\partial rc_1} \cdots \frac{\partial empg}{\partial rc_N}\right] = (I - \rho W)^{-1} \begin{bmatrix} \beta_1 & w_{12}\beta_2 & \cdots & w_{1n} \\ w_{24}\beta_2 & \beta_1 & \cdots & w_{2n} \\ \vdots & \vdots & \ldots & \vdots \\ w_{n1}\beta_2 & w_{n2}\beta_2 & \cdots & \beta_1 \end{bmatrix} \quad (6)$$

where w_{ij} is the (i, j) th of the weight matrix W. As outlined by LeSage and Pace (2009) the direct effect is measured by the average of the diagonal elements while the indirect effect or the element which takes into account spatial spillovers is measured by the average of either row sums of the non-diagonal elements. As we wish to isolate the effects of our measures of diversity on employment growth into direct, indirect and total effects we utilise the estimation proposed by LeSage and Pace (2009).

4. Data

Employment and average income data was obtained for 27 Irish regions (25 counties and two local authorities) from the Central Statistics Office's Business Demography (CSO, 2016a) and County Incomes and Regional Accounts (CSO, 2016b) database for the period 2006-2012. We are restricted to this time period as 2006 marks the first year the Business Demography became available (CSO, 2016a) and therefore it is not possible to calculate the diversity indices prior to this point for Ireland. While certain empirical studies measure diversity and specialization in terms of the Herfindahl index (see Henderson et al. 1995 & Paci and Usai, 2006), with higher values indicating a more specialized region, Frenken et al.

(2004) note that such an approach neglects the important distinction between related and unrelated diversity. Related diversity implies that two distinct sectors share some commonalities, in terms of supply linkages, customers or product characteristics. Unrelated diversity implies that these commonalities do not exist. This distinction, as Bishop (2008) notes, may be important as the generation of positive externalities may be more likely to emerge from related sectors, and in turn have a positive impact on growth. Conversely, a local economy which encompasses many related sectors in theory could be more adversely affected from an economic shock, as the negative effects in one sector have a contagious effect on others. Thus this study includes three measures of diversity; overall diversity and separate related and unrelated measures.

Overall diversity is measured by Total Entropy (TE) (Frenken et al. 2007). If S_i is the share of the i-th 4-digit NACE category in a region's total employment there are n different 4-digit categories, then TE can is defined as follows:

$$TE = \sum_{i=1}^{N} S_i \ln\left(\frac{1}{s_i}\right) \tag{7}$$

The index approaches a maximum of $\ln(n)$ as diversity increases, with low values implying strong specialization. Unrelated Entropy (UE), is calculated similarly as Equation 7 but for 2-digit data, while Related Entropy (RE) is the difference between TE and UE. Therefore, diversity across 4-digit sectors within a particular 2-digit NACE category is regarded as diversity across related sectors, while diversity into more unique sectors denotes unrelated diversity (Bishop 2008). These entropy measures are expressed as a portion of the maximum for each given year. These regional entropy measures have been utilised in Wasylenko and Erickson (1978), Kort (1981), Attaran (1986) and Bishop and Gripaios (2007).

We proxy also for urbanisation economies (POP DEN), industrial and market structure (SERV & COMP). Population density (POP DEN) is utilised as our measure of urbanisation economies. The proportion of local employment in service industries is presented as a measure of industrial structure (SERV).[2] Market structure effects are defined as the proportion of enterprises with fewer than 10 employees (COMP). These are micro firms as defined by the Irish Central Statistics Office, CSO (2011). A location quotient value is estimated for this with a score above 1.0 indicating a particular region is more concentrated in smaller enterprises than the national average. This measure may relate to average business size and proxy for scale effects. Regional Income per person expressed in constant 2014 Euro values is utilised as a proxy of the local wage rate. These controls align with standards in the literature (see Frenken et al. 2007; Bishop, 2008; Bishop & Gripaios, 2010 and Pede, 2013). Figure 1 details the average scores in diversity for each region over the period 2006-2012.[3]

[insert Figure 1 around here]

In Figure 1 darker shades indicate regions with higher diversity scores. We note that regional scores for both Total Entropy (4-digit diversity) and Unrelated Entropy (2-digit diversity) are identical, in the sense those regions who perform well in one, perform well in others. These entropy variables are expressed as a portion of the maximum, in that all regions performance are compared to the most diverse region. In both Total and Unrelated Entropy, Dublin was the most diverse region in regards to employment. Both Cork and Galway scored highly in regards to these diversity measures. This is not surprising, given all three regions encompass large urban areas, which through urbanisation economies, may attract a large and varied labour force.

Turning to the third map which examines Unrelated Entropy – the difference between Unrelated and Total Entropy, we notice the region of Westmeath stands out. Dublin, and adjacent regions score low values in this measure, which may indicate some spatial dependence in regards to diversity. While not visually presented here, we also examined employment patterns. Examining initially employment values for 2006 and 2012, regions with large urban centres such as Dublin, Cork and Galway, Limerick and Kerry have some of the highest levels of employment. This is similar for 2012, yet with an overall decrease across all regions, due to the economic downturn experienced across Ireland, driven by the 2008 global financial crisis.

Moreover, estimating the compound annual growth rate for employment over the time period nearly all regions witnessed falls in employment, with Roscommon and North Tipperary witnessing some of the most substantial. Offaly appears to be an outlier to this trend, actually experiencing a positive compounded average growth rate of 6.7%.

5. Results

Table 1 and 2 presents the results from both spatial and non-spatial estimations. Table 1 presents the results of our estimations of equation (4) when total entropy (diversity) is included, while Table 2 presents the results of the analysis when total entropy is decomposed into its related and unrelated elements. In both instances, we provide the estimation of a pooled OLS model (which ignores spatial effects) in column 1, as well as the estimates for the SDM, SAR model, and the SEM in columns two through four respectively. The purpose of this is to provide a comparison of a baseline non-spatial estimation with our alternative spatial estimations. To assess whether spatial models are required we perform an LR test based on the OLS estimations, as is standard (see Abate (2016), LeSage and Fischer (2008) and Bishop (2008) as examples of this procedure). We note the LR Test suggests controlling for the spatial interaction amongst the data improves the fit of the model above and beyond a non-spatial model. Moreover, when we consider our SDM and SAR model the growth rate of neighbouring regions has a positive and statistically significant effect – denoted by ρ. The SEM also exhibits a significant spatial error process – denoted by λ. This is in line with the studies by Abate (2016), LeSage and Fischer (2008) and Bishop (2008) providing support for the theory that employment growth rates of neighbouring countries/regions positively affect the growth rate of a particular country/region, thus reinforcing the theory of spatial spillovers.

With the presence of heteroscedasity evident in the initial specification, the model was fitted with hetroscedastic consistent standard errors. All variables are expressed in their logarithmic form. As discussed in Belotti et al. (2016) we utilise as the SDM as a general specification and test for alternatives. Therefore, of central importance in Tables 1 and 2 are the results of the tests for model specification presented at the bottom. What we immediately note is that it is possible to (i) reject that $\beta_2 = 0$ and accept that $\rho \neq 0$ and (ii) reject that $\beta_2 = -\beta_1\rho$. The results of (i) signifies that the SDM is preferred over the SAR model while the results of (ii) signifies that the SDM is preferred over the SEM. Therefore, we focus our interpretation on the SDM (as opposed to the other two alternative estimations).

Regarding the estimates presented in Table 1 and 2 we focus our discussion on the results obtained from the SDM presented in column 2 of both tables. However, an interpretation of the coefficients of these models is not ideal, and instead we obtain, based on these coefficients, the direct, indirect and total effects as discussed in the methodology section. It is now standard in the spatial econometrics literature to discuss these effects, as opposed to the actual coefficients of the model (Le Sage and Pace 2009).

[insert Tables 1 and 2 around here]

5.2 Direct, Indirect and Total Effects

In Table 3 the Direct effect measures the impact of a particular explanatory variable in region i on the dependent variable in region i. The Indirect effect measures the effect of changes in variables in region j on the dependent variable in region I where $j \neq i$. Finally, the total effect is the cumulative effect of both the direct and indirect effects on the dependent variable in region i. We begin with a discussion of the total effects and then break this into the direct and indirect components. We note that the effects presented in this section are derived from the SDMs presented in Tables 1 and 2 (our preferred model based on our specification tests).

Beginning with the impact of total diversity on employment growth (Model 2) we observe that the total effect is positive and significant, as is both the direct and indirect effect. This suggests that the more diverse a region is the higher the growth rate of employment over our study period. When breaking this into related and unrelated diversity (in Model 6) we observe that both have a positive impact on employment growth, with the effect being larger for unrelated variety. However, this appears to be comprised of significant indirect effects. This suggests that adjacent regions being diversified in unrelated and related sectors has a positive impact on employment growth for host regions. Given this study is based on administrative boundaries, focusing on either the direct or indirect effects, separately may not be entirely beneficial. For example, given the links between Dublin and neighbouring regions such as Meath, Kildare and Wicklow (known jointly as the Greater Dublin Area), examining the cumulative effect of both the direct and indirect effect, known as the total effect is more applicable.

We note that the total effects from both of the SDMs indicate that population density, regional income, and the service sector (in the case of Model 2) all have negative impacts on employment growth. While (in the case of Model 6) a significant positive competition effect is observed. In the case of Model 2 these effects are comprised of significant direct and indirect effects while in the case of Model 6 the effects are due to direct income effects and indirect population density and competition effects.

These results are consistent with existing literature and provide support for the growing body of work which finds diversity to be important for employment growth and also the growing literature emphasising the importance of considering spatial patterns in the drivers of employment. For example, Frenken et al. (2007) find related diversity to have a positive role on regional (NUTS3) employment growth in the Netherlands and Bishop (2008) for Great Britain finds total and unrelated diversity have a positive impact on employment. We note a positive effect for all three when considering total effects. The results suggest that unrelated diversity has a larger impact on employment growth relative to related variety. This would indicate that although relatedness can benefit regional employment growth it is best stimulated by a broad range of sectors. Frenken et al. (2004) state this may be due to spillovers from unrelated sectors which can stimulate radical innovations, in turn enabling new employment growth. In contrast spillovers in related sectors can yield improvements in productivity rather than substantial employment returns. However, it could also be the case that in Ireland, government intervention through Foreign Direct Investment (FDI) agencies sees unrelated sectors co-located, mitigating the impact market forces can have on firm location.

6. Discussion and Conclusions

The spatial econometrics literature notes spatial interactions in many economic processes affect the conventional relationship of variables (Abate, 2016). As noted by Ehrl (2013) there is no consensus as to the relative significance of different sources of agglomeration economies. In addition to the pure information-based sources of agglomeration economies, additional market-based sources may create pressures for dispersion or agglomeration of economic activity and the empirical evidence varies considerably across locations in terms of both impacts. We investigate the relationship between employment growth and diversity allowing for spatial interactions amongst Irish regions.

Our regional data cover 27 Irish regions over the period 2006-2012. We estimate a suite of spatial models and apply tests as discussed in LeSage and Pace (2009) and Elhorst (2009) to determine the optimal model. Having established the SDM as the optimal model in our case we find that all three diversity measures positively impact employment growth with unrelated diversity having the largest positive effect.

Our findings indicate some evidence of regional resilience to shocks where regional employment structures impact positively on other regions' employment growth due to Total Entropy in employment structures. The limited impact of Related Entropy on regional employment growth does indicate some evidence of contagion mechanisms across regional employment in our results. We note from examining the Indirect results that significant spatial spillovers are evident, thus providing direct evidence that geography, in terms of neighbouring regions, matters.

Our Total Effect results reveals that unrelated diversity has a larger impact on employment growth than related diversity. This implies that although relatedness benefits regional employment growth, regional growth it is best stimulated within a region by possessing a wide breadth of sectors. Frenken et al. (2004) explain such findings in terms of spillovers from unrelated sectors which can stimulate radical innovations that can foster employment growth in new activities or lines of business. In contrast spillovers in related sectors can yield improvements in productivity rather than substantial employment growth. Further exploration of more granular data would be required to substantiate these views.

Our findings could be the outcome of Irish industrial policy where government intervention through agencies tasked with attracting Foreign Direct Investment (FDI) result in such employment being co-located, irrespective of its sectoral specialty, which in turn benefits regional employment growth. While some evidence in support of the policy of industrial clustering in Ireland is available, its rollout in practice has been extremely limited and a finding of relatively lower role for or impact of Related Entropy is not surprising.

The externalities or spill-over effects we consider here may affect output, or productivity only. If employment varies with productivity it would be a consequence of productivity-induced increase in market share. However, as Combes (2000) highlights, if no such market-share gains follow or if the capital/labour substitution rate is high, employment might fall. In this light, the use of employment data, as opposed to productivity data, in analysing local externalities has been criticised in the literature (Cingano and Schivardi, 2004). Not only is there a difficulty in identifying appropriate capital stock data - either aggregate or regional - for such analysis in Ireland, there is an additional complication for the Irish case, however, since it is problematic to use productivity data given the critiques of transfer pricing and its impact on value added (and GDP) data, that questions the reliability of output data.

Our limited panel also does not permit for consideration of lagged effects which could be expected from localization and urbanisation where the lagged effects can take even longer to impact (Henderson, 1997), however, further research as data becomes available can be carried out to test our findings here. Not only this, but a longer time period would be beneficial given the period in question encompassed the worst economic downturn within Ireland. As Bishop and Gripaios (2010) note, the relationship between diversity and employment may alter in more turbulent times.

Notes

1. We utilise county income per person as a proxy of the regional wage rate, due to lack of more appropriate regional wage data.
2. The following *NACE* sectors are used as a definition of the service sector:
   55: Accommodation
   56: Food and Beverage Service Activities
   58: Publishing Activities
   59: Motion picture, video and television programme production, sound recording and music publishing activities
   60: Programming and broadcasting activities
   61: Telecommunications
   62: Computer programming, consultancy and related activities
   63: Information service activities
   64: Financial service activities, except insurance and pension funding
   65: Insurance, reinsurance and pension funding, except compulsory social security
   66: Activities auxiliary to financial services and insurance activities
   68: Real estate activities
   77: Rental and leasing activities
   78: Employment activities
   79: Travel agency, tour operator and other reservation service and related activities

80: Security and investigation activities
81: Services to buildings and landscape activities
82: Office administrative, office support and other business support activities
92: Gambling and betting activities
93: Sports activities and amusement and recreation activities
95: Repair of computers and personal and household goods
96: Other personal service activities

3. This period was chosen due to data limitations.

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Figure 1: Diversity Measures – Average 2006-2012

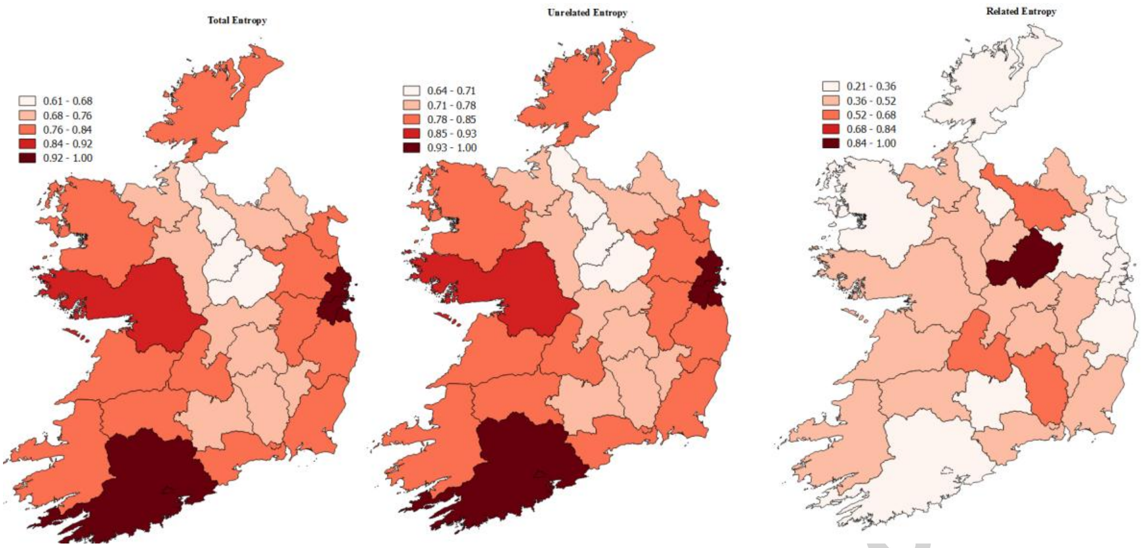

Table 1: Estimates of Equation (4) using alternative model specifications

Variable	Model 1 - OLS		Model 2 - SDM		Model 3 - SAR		Model 4 - SEM	
TE	0.151	***	0.3705	**	0.4829	**	0.161	
	(0.0460)		(0.1856)		(0.2489)		(0.1375)	
Income	-0.041	***	-0.1913	**	-0.1104	**	-0.1456	**
	(0.0080)		(0.0930)		(0.0508)		(0.0757)	
Population Density	-0.085	***	-0.1347		-0.17		-0.0376	
	(0.0190)		(0.1231)		(0.1288)		(0.1128)	
Service	-0.032	***	-0.1086	**	-0.1235	***	-0.0818	*
	(0.0080)		(0.0516)		(0.0448)		(0.0433)	
Small	0.041		0.0246		0.139		0.0948	
	(0.0610)		(0.4656)		(0.4078)		(0.4612)	
W*Income			-0.0902					
			(0.0991)					
W*Population Density			-0.6427	***				

		(0.2008)		
W*Service		-0.0323		
		(0.0982)		
W*Small		-0.2364		
		(0.6330)		
W*TE		0.7278 ***		
		(0.1656)		
ρ		0.6067 ***	0.7486 ***	
		(0.0389)	(0.0308)	
λ				0.8144
				(0.0275)
Obs.	162	162	162	162
R2		0.722	0.6031	0.0663
$\beta_2 = 0$		70.25		
$\beta_2 = -\beta_1 \rho$		61.77		
LR Test	146.17			

Table 2: Estimates of Equation 4 using various model specifications

Variable	Model 5 - OLS	Model 6 - SDM	Model 7 - SAR	Model 8 - SEM
UR	0.085 **	-0.0311	0.383 **	0.0179
	(0.0400)	(0.2036)	(0.1644)	(0.1684)
RE	0.009 ***	-0.0267 **	0.0177	-0.024
	(0.0030)	(0.0135)	(0.0235)	(0.0176)
Income	-0.034 ***	-0.2581 ***	-0.1091 **	-0.1659
	(0.0090)	(0.0898)	(0.0576)	(0.0821)
Population Density	-0.065 ***	-0.0349	-0.1844	-0.0024
	(0.0180)	(0.0981)	(0.1310)	(0.1079)
Service	-0.01	-0.0612	-0.0833	-0.0878
	(0.0090)	(0.0474)	(0.0438)	(0.0346)
Small	0.131	0.2184	0.3787	0.0275 ***
	(0.0700)	(0.5218)	(0.4651)	(0.4804)
W*Income	1.4778 ***			
	(0.6167)			
W*Population Density	0.1579 ***			
	(0.0225)			
W*Service	-0.1788			
	(0.1212)			
W*Small	-0.7629 **			
	(0.3144)			

W*UR	0.0948			
	(0.1391)			
W*RE	2.0954 **			
	(1.0809)			
ρ		0.411 ***	0.7049 ***	
		(0.0691)	(0.0608)	
λ				0.8477 ***
				(0.0228)
Obs	162	162	162	162
R2		0.7948	0.7185	0.0468
		0.0252	0.1014	0.0008
		0.0713	0.0056	0.0076
$\beta_2 = 0$		101.93		
$\beta_2 = -\beta_1\rho$		75.92		
LR Test	132.53			

Table 3: Direct, indirect and total effects derived from Tables 1 and 2

	Derived from Model 2			Derived from Model 6		
	Direct	Indirect	Total	Direct	Indirect	Total
TE	0.5636***	2.2252***	2.7886***			
	(0.1877)	(0.3100)	(0.3968)			
UE				0.0669	1.4778***	1.5447**
				(0.2180)	(0.6167)	(0.7157)
RE				-0.015	0.1579***	0.1429***
				(0.0135)	(0.0225)	(0.0306)
Income	-0.237***	-0.479***	-0.7161***	-0.2738***	-0.1788	-0.4527***
	(0.0902)	- (0.1432)	(0.1670)	(0.0838)	(0.1212)	(0.1143)
Pop Density	-0.2876***	-1.6769***	-1.9645***	-0.0923	0.7629**	-0.8554**
	(0.1349)	(0.4885)	(0.5705)	(0.1018)	(0.3144)	(0.3664)
Service	-0.1284***	-0.2395	-0.3679*	-0.0526	0.0948	0.0421
	(0.0523)	(0.2104)	(0.2356)	(0.0429)	(0.1391)	(0.1458)
Small	0.0019	-0.5518	-0.5499	0.3857	2.0954**	2.4811*
	(0.5040)	(1.4854)	(1.7602)	(0.5457)	(1.0809)	(1.4029)

Highlights

- We study the impact of diversity on employment growth within Irish regions.
- We decompose diversity into its related and unrelated components.
- We note the presence of spatial interaction amongst our variables and adopt a spatial panel estimator approach.
- We find relatedness to be conducive to employment growth but having a broad range of sectors within a region to be more beneficial to employment.